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OVERHEAD PROTECTION FOR AGRICULTURAL TRACTORS—TEST PROCEDURES AND PERFORMANCE REQUIREMENTS—SAE J167a

SAE Standard

Report of Tractor Technical Committee approved July 1970 and last revised February 1974.

1. Purpose—The purpose of this standard is to establish the test and performance requirements of a protective frame or enclosure with overhead cover designed for wheel-type agricultural tractors to minimize the frequency and severity of operator injury resulting from accidental upsets and overhead hazards during normal operation. General requirements for the protection of operators are specified in SAE J333.

2. Scope

2.1 Fulfillment of the intended purpose requires conformance to paragraphs 5 and 6 of SAE J168, and the following additional requirements:

2.1.1 A drop test to verify the effectiveness of the overhead cover in protecting the operator from falling objects.

2.1.2 A crush test to verify the effectiveness of the structure in protecting the operator from large vertical loads.

2.2 The test procedures and performance requirements outlined in this standard are based on currently available engineering data.

3. Definitions

3.1 An agricultural tractor is defined in paragraph 2.1 of SAE J333.

3.2 Tractor weight is defined in paragraph 3.2 of SAE J168.

4. Description—The protective frame or enclosure to which this standard applies is a structure generally comprised of uprights mounted to the tractor and attached to an overhead cover extending above and over the operator's seat and conforming generally to Fig. 1.

5. Specifications for Overhead Cover—Overhead cover may be constructed of a solid material. If grid or mesh is used, the largest permissible opening shall be such that a 1.5 in. (38 mm) diameter circle is the maximum circle that can be inscribed between the elements of the grid or mesh.

6. Test Procedures

6.1 **General**—Appropriate and applicable test procedures are specified in paragraphs 5.1, 5.2, 5.3, and 5.4 of SAE J168.

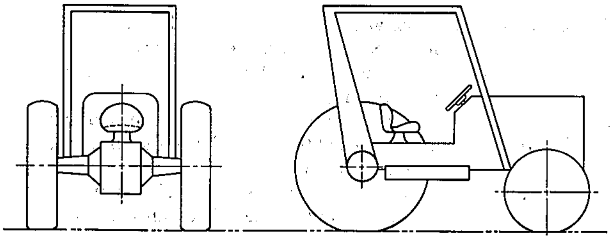
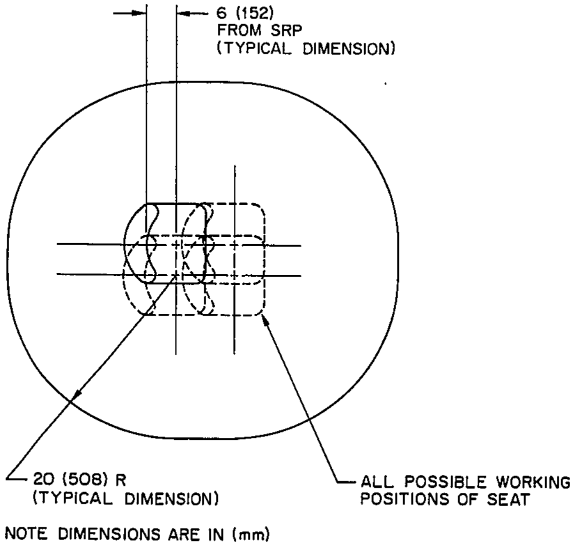


FIG. 1—TRACTOR WITH TYPICAL PROTECTIVE FRAME AND OVERHEAD COVER



NOTE DIMENSIONS ARE IN (mm)

FIG. 2—ZONE OF PROTECTION FOR DROP TEST

6.2 **Drop Test Procedure**

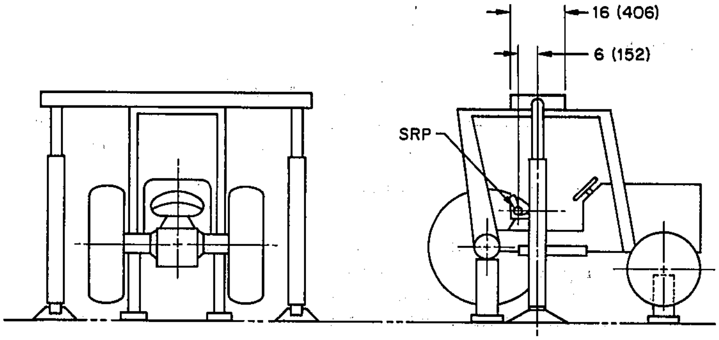
6.2.1 The overhead cover shall be subjected to a drop test using a solid steel sphere or material of equivalent spherical dimension weighing 100 lb (45.4 kg) dropped once from a height of 10 ft (3050 mm) above the overhead cover.

6.2.2 The point of impact shall be on the overhead cover at a point within the zone of protection as shown in Fig. 2 which is furthest removed from major structural members.

6.3 **Crush Test Procedure**

6.3.1 After the frame has been subjected to either static or dynamic loads, the same frame shall be subjected to the crush test.

6.3.2 The test load shall be 1.5 times the tractor weight defined and explained in paragraphs 3.2 and 5.4.1.1 of SAE J168. Load shall be applied as shown in Fig. 3.



NOTE: DIMENSIONS ARE IN (mm)

FIG. 3—METHOD OF LOAD APPLICATION FOR CRUSH TEST

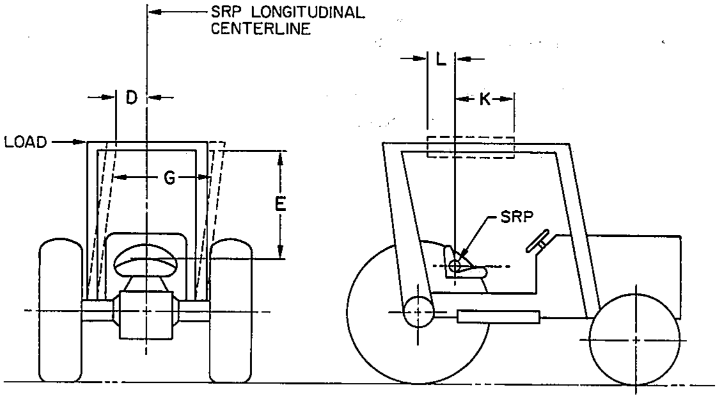


FIG. 4—SIDE LOAD APPLICATION

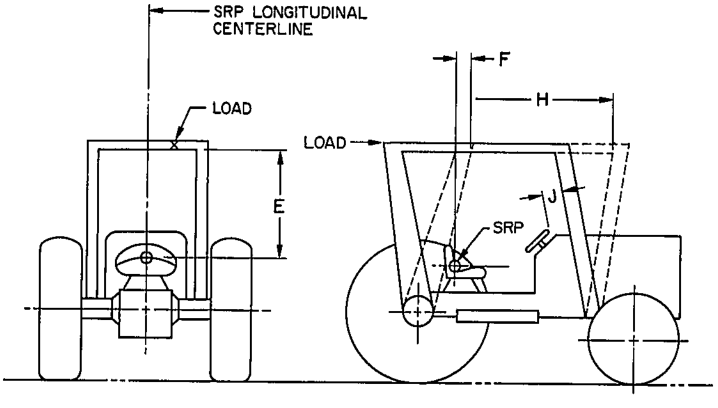


FIG. 5—REAR LOAD APPLICATION

g = acceleration of gravity, by international agreement equal to 9.80665 m/s^2 at sea level.

3.2 **Whole Body Vibration**—As used in this recommendation, this term means vibrations transmitted to the body as a whole through the buttocks of a seated person.

3.3 **Vehicle Seat**—Specifically for the purposes of this document, that portion of the vehicle provided for the purpose of supporting the buttocks of the seated operator.

3.4 **Frequency Analysis**—Process of arriving at a quantitive description of the amplitude of a vibration as a function of frequency.

3.5 **"Ride Meter"**—A vibration analysis instrument of the general type described by Hilton (Ref. 2).

3.6 **Measuring Period**—The time duration in which vibration data for analysis is obtained.

3.7 **Average Ground Speed**—Ratio of the distance traveled during the test period to the time period.

3.8 Other terminology used in this recommendation is in accordance with ANSI S1.1 and ISO DR 2041 (Refs. 3, 4).

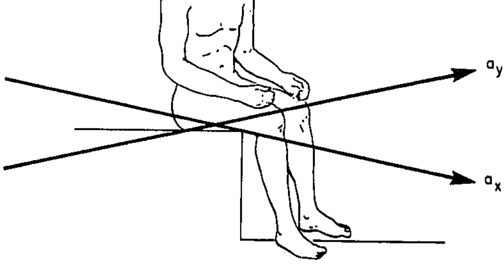
4. *Vibration Measurement Axes*—The vibration shall be measured along three mutually perpendicular axes, passing through a point on the interface between the operator and the vehicle seat. These axes are substantially vertical, longitudinal, and lateral (a_z, and a_x, a_y) with respect to the orientation of the seated operator and are defined in Fig. 1. The operator should sit in a typical upright position and should keep both hands in a normal position for operating the controls as suggested by Fig. 1. Armrests on seats so equipped should either be folded up or removed (where practical) to prevent the operator from leaning on them during the test. Such a posture would significantly influence the test results.

5. *Instruments*

5.1 **Vibration Pickups**—The vibration shall be sensed by acceleration transducers (accelerometers) attached near the center of a thin disc 200 ± 5 mm in diameter placed between the operator and the vehicle seat. The primary requirements for the disc are that it provide a suitable mounting for the accelerometers, not disturb operator comfort, and not significantly distort the buttock-cushion load distribution. Either a rigid or semirigid disc may be used; however, the semirigid type is recommended especially for rather soft or highly contoured cushions. Suggested disc designs are shown in Figs. 2 and 3. Either disc shall be placed on the seat so that the accelerometer assembly is midway between the ischial tuberosities. If a rather rough ride is expected, the disc should be taped or similarly attached to the cushion to maintain its location.

The transducers, together with their associated amplifiers, shall be sensitive to vibration levels of 0.5 m/s^2 and shall be capable of measuring vibrations of 5 m/s^2 rms with a crest factor as great as 3 without amplitude distortion of more than ±1% in the range 0.1–100 Hz. Acceleration sensitivity shall not vary in the range of 0–100 Hz by more than ±5%.

5.2 **Magnetic Tape Recorder**—The electrical signals generated by the transducers may be recorded for later analysis on magnetic tape. The magnetic tape recorder should have a replay accuracy of better than ±2% over the frequency range of 0–100 Hz, including any change in tape speed during replay for the purpose of analysis.



a_x, a_y, a_z = ACCELERATION IN THE DIRECTIONS OF THE x, y, z, AXIS
x-axis = DIRECTION OF THE BACK-TO-CHEST
y-axis = RIGHT-TO-LEFT SIDE
z-axis = BUTTOCKS-TO-HEAD

FIG. 1—MEASUREMENT AXES

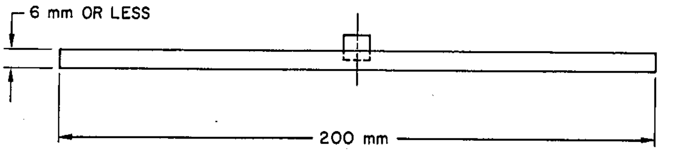


FIG. 2—SUGGESTED DESIGN FOR RIGID DISC WITH ACCELEROMETER ASSEMBLY BONDED AT CENTER

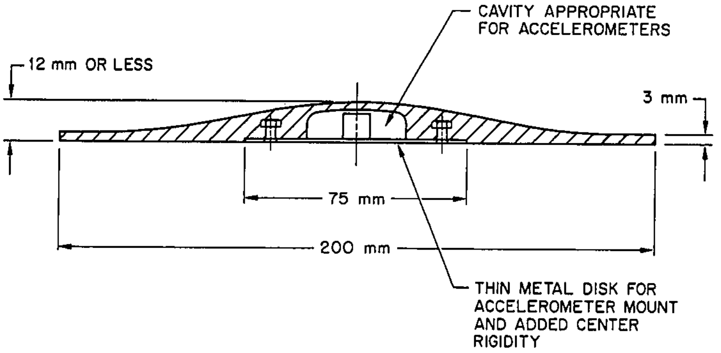

CAVITY APPROPRIATE FOR ACCELEROMETERS
12 mm OR LESS
3 mm
75 mm
200 mm
THIN METAL DISK FOR ACCELEROMETER MOUNT AND ADDED CENTER RIGIDITY

FIG. 3—SUGGESTED DESIGN FOR SEMI-RIGID DISC OF APPROXIMATELY 80-90 DUROMETER (A-SCALE) MOLDED RUBBER, PLASTIC, ETC.

5.3 **Frequency Weighting**—Frequency weighting may be achieved in either of two ways: by analysis of the acceleration into ⅓ octave band levels, weighting the levels in individual bands and recombination; or by direct use of electrical filters in a frequency weighting "ride meter."

5.3.1 FREQUENCY ANALYSIS METHOD—Each vibration tape recording shall be analyzed into ⅓ octave component accelerations over the frequency range 1.0–80 Hz. The ⅓ octave center frequencies shall be in compliance with IEC Publication 225 (Ref. 5) which must be extrapolated for the lower frequencies. The rms value of each component (b_f) shall be averaged over the duration specified for the measurement. The ⅓ octave values shall each be multiplied by the weighting factors (w_f) listed in Table 1, and a weighted acceleration (B_w) value calculated for each recording as the square root of the sum of the squares of the weighted ⅓ octave values.

$$B_w = \left[\sum_{f=1}^{80} W_f^2 b_f^2\right]^{1/2}$$

5.3.2 FREQUENCY WEIGHTING "RIDE METER"—The "ride meter," if employed for direct indication of the weighted vibration, shall consist of an electronic weighting network incorporated between the transducer and a time integration stage. The weighting network shall have an insertion loss according to the curve in Fig. 4 for vertical vibration, or Fig. 5 for horizontal vibration. The loss shall not deviate from the curve by more than ±1 dB at 6.3 and 31.5 Hz for vertical measurement or at 1.25 and 31.5 Hz for horizontal measurement, and ±2 dB at any other frequency. The integration stage shall be capable of indicating the integral of the square of weighted acceleration (b_w^2) for the time period of the test run (T). That is,

$$I = \int_{t=0}^{T} b_w^2 dt$$

5.3.3 CALIBRATION—The entire measurement and analysis system should be regularly calibrated by technically trained instrumentation personnel following manufacturer's recommendations for the adjustment and application of individual components.

Acceleration pickups should be calibrated in accordance with a suitable recognized calibration method such as outlined in ANSI S2.2-1959 (Ref. 6).

Where a tape recorder is employed as part of the data acquisition system, the tilting support method (ANSI S2.2-1959) for static calibration of acceleration pickups should be used to obtain overall system acceleration sensitivity for each of the three data channels. Tilting the sensitive axis of each pickup in the field of gravity provides a peak-to-peak change in output representing a 2g change in input acceleration. This signal should be recorded immediately before and after each run.

The output from each accelerometer amplifier should be nulled by proper

6.3.3 Maximum width of the beam shown in Fig. 3 shall be 16 in. (406 mm).

7. Performance Requirements

7.1 General Requirements

7.1.1 Performance requirements specified in paragraphs 6.1.1, 6.1.2, and 6.1.3 of SAE J168 shall apply.

7.1.2 Additional performance requirements as specified in paragraphs 7.2 and 7.3 of this standard shall apply when applicable.

7.2 Drop Test Performance Requirements

7.2.1 Instantaneous deflection due to impact of the sphere shall not enter the protected zone as illustrated in Figs. 2, 4, and 5.

7.2.2 Minimum allowable dimensions are listed in paragraph 6.1.1 of SAE J168.

7.3 Crush Test Performance Requirements—The protected zone as described in Figs. 4 and 5 shall not be encroached. (For dimensions, see paragraph 6.1.1 of SAE J168.

[redacted]